

## SECTION 02648 - CURED-IN-PLACE PIPE LINER

### City of San Diego, CWP Guidelines

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NTS: This specification is structured to foster cost based competition between Insituform using isophthalic polyester resin and InLiner using an epoxy vinyl ester resin. Note that the two resins are not exactly comparable in chemical resistance performance in strongly alkaline environments. In sewer reaches where an industrial discharge might push sewage pH more alkaline than 11.0, the epoxy vinyl ester resin is the appropriate choice of the two, and this section must be edited accordingly. In most sewers, where the pH is expected to be closer to neutral than pH of 11, both manufacturer's products can be considered.

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#### PART 1 -- GENERAL

##### 1.1 WORK OF THIS SECTION

- A. The WORK of this Section includes providing cured-in-place pipe (CIPP) liner for rehabilitation of sanitary sewer pipelines. The liner shall be a smooth, hard, strong, and chemically inert interior surface closely following the contours of the host pipe.

##### 1.2 RELATED SECTIONS

- A. The WORK of the following Sections apply to the WORK of this Section. Other Sections of the Specifications, not referenced below, shall also apply to the extent required for proper performance of WORK.
  - 1. 02200 - Earthwork
  - 2. 02730 - Sanitary Sewerage System Testing

##### 1.3 STANDARD SPECIFICATIONS

- A. Except as otherwise indicated in this Section of the Specifications, the CONTRACTOR shall comply with the Standard Specifications for Public Works Construction (SSPWC), as specified in Section 01090 - REFERENCE STANDARDS.

##### 1.4 SPECIFICATIONS AND STANDARDS

- A. Except as otherwise indicated, the current editions of the following apply to the WORK of this Section:

ASTM C 581	Standard Practice for Determining Chemical Resistance of Thermosetting Resins Used in Glass-fiber-reinforced Structures Intended for Liquid Service.
ASTM D 790	Test Methods for Flexural Properties of Unreinforced and Reinforced Plastics and Electrical Insulating Materials.
ASTM D 903	Standard Test Method for Peel or Stripping Strength of

## Adhesive Bonds

ASTM D 5813

Cured-In-Place Thermosetting Resin Sewer Pipe

ASTM F 1216

Standard Practice for Rehabilitation of Existing Pipelines and Conduits by the Inversion and Curing of a Resin-Impregnated Tube.

### 1.5 SHOP DRAWINGS AND SAMPLES

- A. The following shall be submitted in accordance with Section 01300.
1. Certified copies of test reports on physical properties and chemical resistance of the proposed resin.
  2. Information from the resin manufacturer including specifications, characteristics, properties, and methods of application, including a written certification that the resin material is appropriate for the intended application.
  3. Certified copies of test reports on CIPP coupons obtained during installation.
  4. Analysis of design criteria and calculations for CIPP thickness.
  5. Schedule for "wet out" of the flexible tube. Also submit the insertion and heating schedule/plan at least 24 hours in advance of installation.

### 1.6 INSTALLER QUALIFICATIONS

- A. The CONTRACTOR or subcontractor performing the WORK of this section shall be employees of the company manufacturing the CIPP system components.

## PART 2 -- PRODUCTS

### 2.1 MATERIALS

- A. Flexible Tube
1. The flexible tube shall be one or more layers of needled felt or equivalent woven or non-woven material manufactured under quality controlled conditions set by the manufacturer. Tube shall be sized so that, when installed, it will fit snugly inside the existing sewer and produce the required thickness after the resin is cured.
  2. The minimum length of the flexible tube shall be as necessary to effectively and fully span the distance between manholes, with allowance for proper stretching or shrinkage due to pressure or expansion.
  3. The tube shall contain no intermediate layers which delaminate after resin curing. It shall not be possible to separate any layers with a probe or knife blade such that the layers separate cleanly or the probe or knife blade moves freely between the layers.
- B. Resin

1. The resin used to impregnate the tube shall produce a cured tube which shall be resistant to abrasion from solids, grit, and sand in wastewater. The resin shall have proven resistance to the municipal wastewater environment. The internal wall color of the cured liner shall be white or light brown.
2. The chemical resistance of the resin system selected shall have been tested by the resin manufacturer in accordance with ASTM C 581. Exposure to the chemical solution listed below shall result in a loss of not more than twenty percent of the initial physical properties when tested in accordance with ASTM C 581 for a period of not less than one year.

CHEMICAL SOLUTION	CONCENTRATION, %
Tap Water (pH 6-9)	100
Nitric Acid	5
Phosphoric Acid	10
Sulfuric Acid	10
Gasoline	100
Vegetable Oil	100
Detergent	0.1
Soap	0.1

3. The resin system shall be manufactured by a company selected by the CIPP supplier. Only polyester and vinyl ester resins complying with the following requirements shall be used.
4. Polyester Resin. A resin created by reaction products between isophthalic/terathalic acid, maleic anhydride, and a glycol characterized by reactive unsaturation located along the molecular chain. This resin is compounded with a reactive styrene monomer and reacted together with initiators/promoters to produce cross-linked copolymer matrices.
5. Vinyl Ester Resin. A resin created by reaction products of epoxy resins with methacrylic acid and characterized by reactive unsaturation located in terminal positions of the molecular chain. This resin is compounded with a reactive styrene monomer and reacted together with initiators/promoters to produce cross-linked copolymer matrices.

#### C. CIPP Properties

1. The CIPP after curing shall meet the minimum structural properties listed below:

PROPERTY	REFERENCE	MINIMUM VALUE
Flexural Strength	ASTM D 790	4,500 psi
Flexural Modulus of Elasticity	ASTM D 790	250,000 psi

NTS: Refer to the Engineering Design Guide for Cured-In-Place Pipe published by InLiner USA (800-299-2477) and the Insituform Engineering Design Guide (619-451-0977) for the approach and equations for calculating the applicable minimum CIPP thicknesses in the table below.

From closed circuit TV or visual inspections, be prepared to select between "partially deteriorated" and "fully deteriorated" host pipe conditions. "Partially deteriorated" pipe is cracked or corroded but has no missing sections, and the host pipe is capable of supporting all soil and surface loads. "Fully deteriorated" pipe has insufficient structural capacity to support soil and surface loads due to missing sections, loss of original pipe shape, severe, complete corrosion, or the pipe is expected to reach such conditions during the design life of the rehabilitation.

#### D. CIPP Thickness

1. The CIPP after curing shall satisfy the minimum thicknesses in the following table.

MINIMUM CIPP THICKNESS				
NOMINAL SEWER DIAMETER (INCHES)	PIPE INVERT DEPTH			
	Up to 10 feet (in)	10 - 15 feet (in)	15 - 20 feet (in)	20-25 feet (in)
6				
8				
10				
12				
15				
18				
21				
24				
30				
36				
42				
48				
54				

2. The minimum thickness for the CIPP after curing has been calculated based on the following design conditions:
  - a. The existing sewer is considered [partially] [fully] deteriorated.

- b. The existing sewer is considered to have an ovality of [2] percent in circumference.

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NTS: If CIPP segments are subject to other dead loads, the minimum thickness for such segments should be calculated based on the additional dead load as identified below.

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- c. The CIPP is subjected to a full soil load of [120] pounds per cubic foot.

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NTS: If CIPP segments are subject to other live loads such as railroad, the minimum thickness for such segments should be calculated based on the higher live loads.

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- d. The CIPP is subjected to traffic line loads as calculated by AASHTO Standard Specifications for Highway Bridges, HS-20-44 Highway Loading.

- e. The modulus of soil reaction for pipe zone backfill material is [1000] psi.

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NTS: If CIPP segments are subject to higher groundwater elevations such as a 100-year flood elevation, the minimum thickness for such segments should be calculated based on the higher groundwater elevation.

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- f. The CIPP is subject to a groundwater elevation [5 feet below the ground surface].

- g. The long-term flexural strength and long-term flexural modulus of elasticity for CIPP is equivalent to [50] percent of the initial flexural strength and initial flexural modulus of elasticity, respectively, as measured in accordance with ASTM D 790.

- h. The maximum deflection is 5 percent in the vertical axis.

- i. The minimum overall factor of safety is 2.0.

3. The thickness of the CIPP shall be within minus 5 percent and plus 10 percent of the minimum thickness. Thickness greater than required shall not be allowed if hydraulic capacity of the pipe is reduced. The required thickness shall be measured accurately using properly calibrated calipers.

## **PART 3 -- EXECUTION**

### **3.1 DELIVERY, STORAGE, AND HANDLING**

- A. If the flexible tube is impregnated with resin at the factory, it shall be transported, installed, and cured before expiration of the shelf life.
- B. Impregnated tube shall be stored and transported under refrigerated, ultraviolet light-free conditions.

- C. No cuts, tears, or abrasions shall occur during handling. The CONSTRUCTION MANAGER may inspect the tube before it is placed into the host pipe.

### 3.2 DIVERSION PUMPING

- A. Install and operate diversion pumping equipment to maintain sewage flow and to prevent backup or overflow.
- B. Design all piping, joints, and accessories to withstand twice the maximum system pressure or 50 psi, whichever is greater. A spare pump and piping shall be at the site, ready for use in case of a breakdown.
- C. In the event of accidental spill or overflow, immediately stop the overflow and take action to clean up and disinfect spillage. Notify the CONSTRUCTION MANAGER.

### 3.3 PRE-INSTALLATION CLEANING AND INSPECTION

- A. [Except in areas indicated on the Drawings to be cleaned by gentle methods, the] [The] sewer shall be cleaned according to SSPWC subchapter 500-1.1.4. The CONTRACTOR is responsible for selecting the cleaning method.
- [B. In areas indicated for cleaning by gentler methods, the CONTRACTOR may select any of the three methods in SSPWC subparagraph 500-1.1.4 except that:
  - 1. The movable dam in the hydraulically propelled equipment method may be of smaller diameter than the host pipe inside diameter.
  - 2. The water pressure and nozzle velocity in the hydrocleaning method shall be less than required by SSPWC subparagraph 500-1.1.4.
  - 3. Bucket machines shall not cause any damage to the crown or sides of the pipe.]
- C. All debris removed from the sewer during cleaning shall be transported in watertight containers to the OWNER's treatment plant and be discharged as directed by the plant personnel.
- D. Perform a closed circuit TV inspection according to SSPWC subparagraph 500-1.1.5 immediately before installation of the resin impregnated flexible tube. Verify that sewer is clean and pipe conditions are as necessary for installation of CIPP. A pivot head camera shall be used in pipelines larger than 6 inches diameter to allow for detailed inspection. A copy of the VHS video tape shall be submitted to the CONSTRUCTION MANAGER for review and approval before liner installation begins.

### 3.4 OBSTRUCTION REMOVAL AND POINT REPAIR

- A. The CONTRACTOR shall make point repairs and remove obstructions by non-excavation methods at locations identified on the Drawings. The OWNER may direct additional point repair and obstruction removal based on the pre-installation television inspection above. Point repairs and obstruction removal directed by the OWNER will be added to the WORK of this Section by Change Order.
- B. Pipe materials shall be the same type as the existing pipe. [Reinforced concrete pipe shall be in accordance with Section 02616.]

C. Excavation for Point Repair

1. Excavate the existing pipe at the point of obstruction to the minimum length known to require replacement. Determine the condition of the pipe by internal lamping at least 10 feet in both directions and further excavate any additional length to be replaced. Obtain approval from the CONSTRUCTION MANAGER before excavating beyond the minimum length.
2. Remove and replace failed pipe and pipe with obstructions, using Fernco couplings, matching the slope and grade of the existing pipe.
3. Conduct a pressure test of the repaired line in accordance with Section 02730. Repair and retest if the replaced pipe fails the test.

3.5 INSTALLATION PROCEDURES

A. Wet Out

1. Thoroughly saturate flexible tube prior to installation. Catalyst system or additives compatible with the resin and flexible tube shall be as recommended by the manufacturer.
2. Handle the resin impregnated flexible tube to retard or prevent resin setting until it is ready for insertion.

B. Insertion

1. Insert flexible tube through an existing manhole by means of procedure approved by the manufacturer.
2. The addition of water, air, or steam pressure shall be adjusted to cause the impregnated flexible tube to invert from manhole to manhole, holding the tube tight against the host sewer pipe.

C. Curing

1. After insertion is completed, apply a suitable heat source with a water or steam recirculation system capable of delivering hot water uniformly throughout the section to achieve a consistent cure of the resin. Curing temperatures and durations shall be as recommended by the manufacturer.
2. The heat source shall be fitted with suitable monitors to gauge the temperature of incoming and outgoing water or steam supply. Additional gauges shall be placed between impregnated tube and invert of the original pipe at the manholes to monitor outside liner temperatures during resin curing process. A standby heat source shall be at the site, ready for service in case of a breakdown.
3. Heating shall continue uninterrupted until the desired temperature is achieved. Temperatures at both ends shall be measured and recorded. The initials of the CONSTRUCTION MANAGER shall be obtained on curing logs. Initial cure may be considered completed when exposed portions of the flexible tube pipe take a hard set and temperatures are adequate, as recommended by the manufacturer.

- D. Cool Down: Cool the CIPP in accordance with the manufacturer's instructions. Do not release internal pressure in a way that can create a vacuum and damage the CIPP.

- E. Finished Pipe: The finished CIPP shall be continuous and free from visual defects such as foreign inclusions, dry spots, pinholes, delamination, and wrinkles larger than 2 percent of the diameter. Any section of lining with such defects shall be removed and replaced at no additional cost to the OWNER.

### 3.6 MANHOLES

- A. The CIPP shall make a tight seal at the manhole opening with no annular gaps. Under all circumstances, a ½-inch-diameter activated Oakum band soaked in sealant shall be applied all around for a seal. Complete the sealing procedure before proceeding to the next CIPP segment.
- B. Use Class 560-C-3250 concrete according to SSPWC subsection 201-1.1.2 to form a smooth transition with a reshaped invert and a raised manhole bench to eliminate sharp edges of CIPP, concrete bench, and channel invert. Build up and smooth invert of manhole to match flow line of new CIPP.

### 3.7 FIELD TESTING

- A. Obtain samples of cured liner according to ASTM F 1216 for flexural properties and analyze according to ASTM D 790. Analysis shall be performed by an independent laboratory acceptable to the OWNER. Submit the report to the CONSTRUCTION MANAGER.
- B. A sample of cured liner from the testing above shall be subject to delamination tests by aggressively prying and separation into layers with a knife or sharp-edged instrument. No separation shall be possible. Results shall be included in the report above.
- C. After curing, perform leakage testing in accordance with Section 02730. Repair if necessary and retest.

### 3.8 POST-TELEVISION OF COMPLETED WORK

- A. Submit to the CONSTRUCTION MANAGER a color VHS video tape showing completed WORK.
- B. Correction of failed CIPP or CIPP deemed defective from post-installation television inspection or test reports for structural values, thickness, etc., shall be repaired at no extra cost to the OWNER. Method of repair, which may require field or workshop demonstration, shall be approved by the CONSTRUCTION MANAGER.

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